USDA Forest Service National Fire Plan

Research & Development

science

management

research

2002 Business Summary

Photos provided by USDA Forest Service Research and Development; Joint Fire Science Program; The National Interagency Fire Center Image Portal; Bureau of Land Management; and Alfred H. Golub, The Modesto Bee (center photo, page 35).

The National Fire Plan
USDA Forest Service

Managing the Impacts of Wildfires on Communities and the Environment

Acknowledgments

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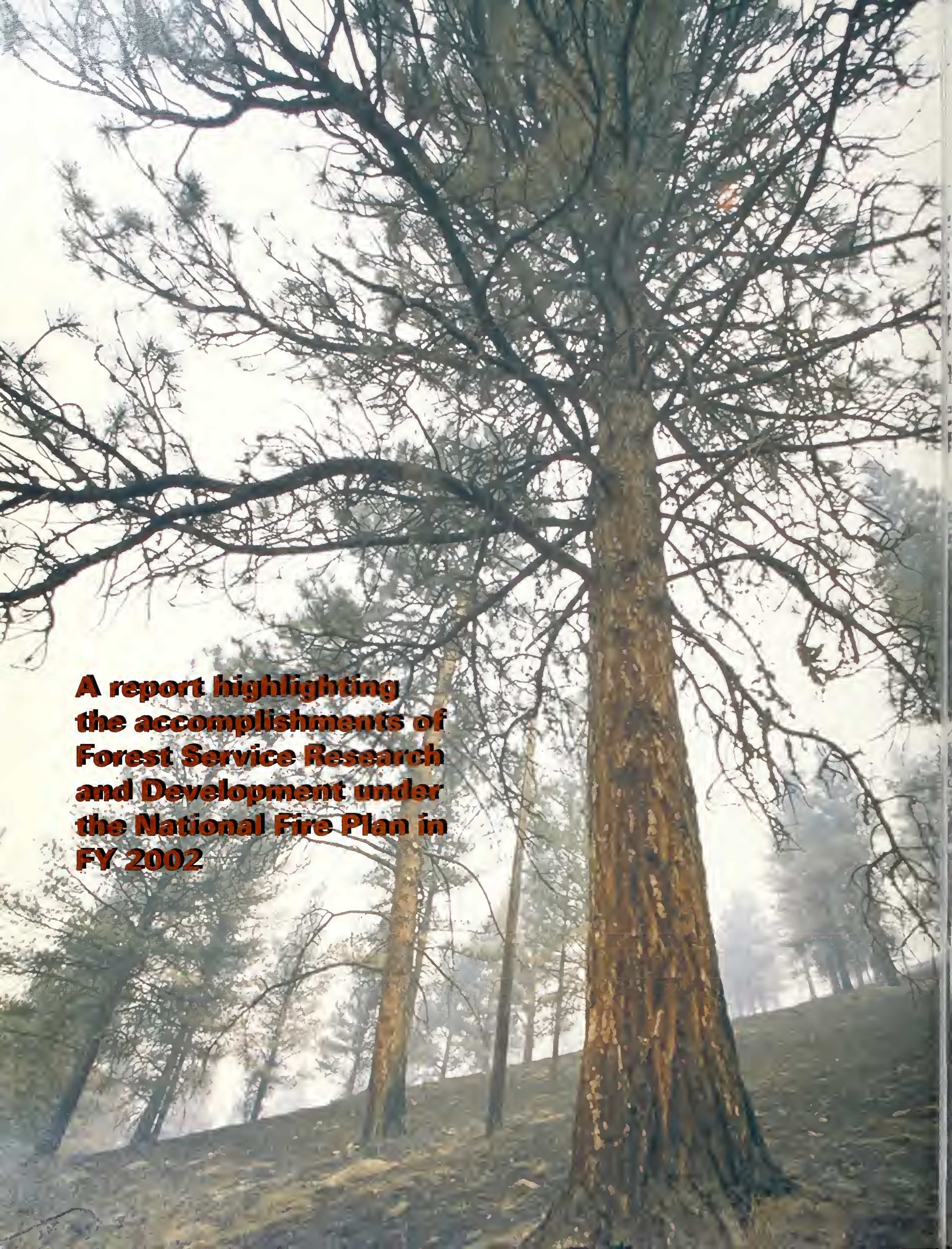

A report highlighting the accomplishments of Forest Service Research and Development under the National Fire Plan in FY 2002

Contents

Executive Summary

Executive Summary

The value of the National Fire Plan (NFP) research program became evident in the long hot fire season of 2002. It showed up in the new tools that helped fire managers deploy firefighting resources more safely and efficiently. It was seen in the better information available about fire location, dynamics, and smoke. Communities at the edge of wildlands found the value of NFP research in new options that allowed them to better prepare for fire in the wildland-urban interface. And later, after the flames of 2002 died down, the value of NFP research was evident in the aftermath, such as in the new discoveries about fire effects on exotic weed populations that will help managers reduce the potential for undesirable weed invasion in burned areas.

The National Fire Plan laid the foundation for a long-term program of work to reduce fire risk and restore healthy fire-adapted ecosystems in the Nation's forests and rangelands. The multifaceted nature and scope of the issues involved in these endeavors necessitates innovative approaches. Researchers are working to provide new information and tools that will help managers achieve the goals set out in the National Fire Plan.

In 2002, for the second year, Forest Service Research and Development (R&D) received funding from the NFP, building upon the investment of $26 million in 2001. NFP research projects are now being conducted in all 50 States. Seventy-eight research teams continue to establish new cooperative studies and contracts with universities and other research partners, produce publications, and transfer new technologies to fire managers. Scientists funded by the NFP have provided technical assistance to National Forest System regions, forests, and districts; to State, local, and tribal governments; and to community and other groups on fire-related topics.

Guided by the strategic goals outlined in the NFP and the 10-year Comprehensive Strategy (which extends the NFP focus into a broader, more collaborative effort), fire research continued to expand in four areas:

- **Firefighting capacity**—improving firefighting decisions.
- **Rehabilitation and restoration**—restoring landscapes and rebuilding communities damaged by wildfire.
- **Hazardous fuels reduction**—reducing fire risk through fuels (combustible forest materials) treatment.
- **Community assistance**—working with communities to reduce fire hazards and ensure adequate protection.

Among their accomplishments in FY 2002, NFP research teams:

- Improved models for predicting smoke dispersal, fire behavior, and fire weather,
- Monitored active fires from aircraft to evaluate and test models,
- Improved manager accessibility to remote sensing data,
- Conducted a strategic analysis of fuel reduction needs in the West,
- Began a study of effects of wildfire on streams and fish populations,
- Addressed utilization of small-diameter timber,
- Evaluated community preparedness for wildland fire, and
- Assessed the impacts of wildfire on local economies.

Key quantitative accomplishments from NFP funding for Forest Service R&D in 2001 and 2002 include:

	2001	2002
Number of studies initiated	252	285
Number of scientists/professionals hired[1]	49	55
Number of cooperative agreements and contracts established	167	162
Number of publications	35	164
Number of consultations with FS regions, national forests, districts	124	273

[1] Includes permanent and term hires.

During 2002, vital partnerships among Forest Service NFP research, Forest Service base fire science research, and the interagency Joint Fire Science Program have helped coordinate research planning and implementation. For many NFP research projects, the ability to leverage multiple sources of funding has allowed faster and more efficient accomplishment of objectives. Exchange of information and coordination between these components of the overall fire research enterprise is being advanced through the recent creation of an interagency Fire Research Coordination Council, which will eventually include representatives from all agencies with fire research programs.

Introduction

Introduction

The National Fire Plan (NFP), initiated in 2001 in response to the devastating fire season of 2000, has helped to jump-start much needed fire management and fire research activities. Over the past 2 years the Forest Service and the agencies of the Department of the Interior have made considerable progress in reducing hazardous fuels and assisting interface communities in preparing for fire. The fire research community that includes Forest Service Research and Development (R&D) and the Joint Fire Science Program (JFSP) has accelerated efforts to improve the science base for fire management. A strong science foundation is key to managing the wildfire hazard and supporting management decisions in the most cost-effective and environmentally sensitive way. Supported by scientific knowledge, decisionmakers are better equipped to more reliably forecast or prevent damaging fires and to understand the consequences of their decisions for society and for forest and rangeland health.

The benefits of NFP research are multifaceted—not just journal publications, but also interpretation, science synthesis, development of useful models and decision support tools, critical advice in postfire response, education of managers and citizens, and connection with the larger science community. Under the NFP, research progress is being made to improve firefighting effectiveness, enhance recovery of burned ecosystems, improve programs for hazardous fuels reduction, and enhance community preparedness.

Science Support for the Healthy Forests Initiative

In August 2002, President Bush announced his new Healthy Forests Initiative that identifies steps to reduce the risk of catastrophic wildfires and improve the health of the Nation's forests. Streamlining review processes for forest restoration activities and increasing the efficiency and effectiveness of management decisions are at the heart of this effort. The initiative implements core components of the National Fire Plan's 10-year Comprehensive Strategy and Implementation Plan adopted by Federal, State, local and tribal officials last spring. National Fire Plan research plays a key role in realizing initiative goals by providing managers with tools to identify uncertainties and levels of risk associated with management decisions, evaluating the consequences of action as well as inaction, and assessing tradeoffs. National Fire Plan researchers continue to work on finding answers to scientific questions related to fire behavior, fire risk assessment and mitigation, and biomass utilization that will move us forward in managing forest health with sound science.

Improved Firefighting Effectiveness

In battling wildfires, managers must make decisions in the face of great uncertainty and complexity. NFP researchers are working on models and tools to assist managers in these decisions. This includes developing better predictions of local fire weather, more accurately predicting fire behavior and smoke dispersal, and providing real-time information and decision tools to fight fires cost effectively and safely. Better predictions mean more cost-effective decisions about deployment of firefighting resources and increased firefighter safety.

Enhanced Recovery of Burned Ecosystems

After wildfires, Federal, State, and local agencies worry about maintaining water quality, minimizing impacts of accelerated erosion, and bringing back native vegetation. NFP researchers are investigating methods to minimize erosion and flooding damage and to optimize conditions for recovery of native vegetation in burned areas. Results of this research will help land managers apply and evaluate burned-area emergency rehabilitation treatments and develop procedures for monitoring restoration effectiveness. Researchers are also investigating interactions between fire and invasive weed species to help managers detect, predict, and minimize the spread of exotic weeds and their negative effects on fire regimes and ecosystem health.

Scientists are working to give native plants a competitive edge over exotic weeds.

Improved Programs for Hazardous Fuels Reduction

One important way to reduce fire risk to communities and fire damage to ecosystems is by reducing the buildup of brush, small trees, and other fine fuels that may feed high-intensity fire. Research on hazardous fuels reduction is helping managers set priorities and balance the complex tradeoffs between benefits of an expanded fuel reduction program and the possible environmental, ecological, and social consequences of mechanical treatments and prescribed burning treatments.

Enhanced Community Preparedness

Fuel treatments alone are not enough to keep a community safe from fire. These treatments must be integrated into an overall strategy that involves the community. Three lines of defense—at the home site, in the vegetation surrounding the community, and in the wildland area—are important in solving the wildfire problem. Community residents and their leaders must be able to understand the rationale for fuel treatments and for how community structures and plans can be modified to reduce overall fire risks. NFP research is helping develop new ways to reduce community vulnerability and increase preparedness by strengthening the lines of defense while letting fire play its natural role.

In fiscal year 2002 Forest Service R&D was scheduled to receive $27.3 million through the NFP to continue funding for 63 research teams. However, Congress designated $5 million of the funds as emergency funds and $1 million to the University of Montana Landscape Fire Center; $415,000 was designated to special national studies and national program administration. This left $20.9 million for NFP teams. Forest Service State and Private Forestry provided an additional $5 million from hazardous fuels funds to fund 15 new research teams. In addition, some of the existing teams were able to invest carryover funds from FY 2001. Funding amounts for the four key areas of firefighting capacity, rehabilitation and restoration, hazardous fuels reduction, and community assistance, as well as funding for special projects, appear below:

Key point	**Funding level** *(\$1,000s)*	**Teams** *(Number)*
Firefighting capacity	$8,740	26
Rehabilitation and restoration	$3,565	12
Hazardous fuel reduction	$10,728	29
Community assistance	$3,415	11
Special national-scale projects and administration	$415	NA
TOTAL	$26,863	78

Accomplishments

Accomplishments

This report summarizes the progress made by Forest Service NFP R&D in FY 2002, the second year of NFP funding. Fire research conducted by Forest Service R&D is working to provide the scientific foundation necessary to increase firefighting safety and effectiveness, enhance restoration of fire-scarred landscapes, reduce fire risk through improved management of hazardous fuels, and better prepare communities to cope with wildfires.

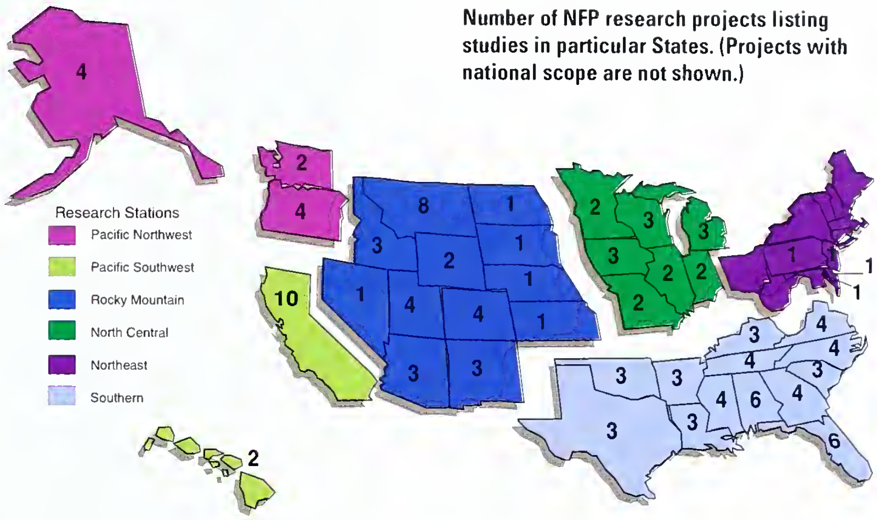
The following accomplishments sections describe tool development, technology transfer and partnerships, research advances, and research highlights in these four key areas.

Scientists continue to provide analytical judgment and ask hard questions in the face of volatile controversies about what should be done about the growing fire problem. The solutions developed for the wildfire problem are only as good as their scientific and technical foundations.

Researcher is sampling spores of white pine blister rust, an exotic pathogen on whitebark pine in the Greater Yellowstone Area. White pine blister rust was accidentally introduced to western North America in the early 1900s and is spreading through white pine ecosystems. Although white pine has little timber value, it plays an important ecological role in forest succession after fire. Researchers are working on identifying and selecting sources of white pine seeds that display hardiness and resistance to this pathogen so that they may be used in efforts to restore burned areas. (Photo by Deborah Croswell)

Accomplishments: Firefighting Capacity

NFP research in the area of firefighting capacity is working to improve firefighting preparedness through better risk assessment methodology, better tools for resource allocation, and improved fire weather and smoke dispersion modeling. Researchers are working in partnership with fire managers to apply these tools and make them more generally available to firefighters. Advances in fire research are providing the foundation for the next generation of tool development. A sampling of accomplishments from firefighting research is highlighted below.



Number of NFP research projects listing studies in particular States. (Projects with national scope are not shown.)

Tool Development

Recent efforts at developing tools for use in fighting fires and conducting prescribed burns have been targeted at improved prediction of fire risk, fire behavior, and smoke movement. Researchers are also working hard to deliver user-friendly versions of research software to managers for use in planning and implementing fuel treatments and other land management activities. Special accomplishments researchers have made include:

- Developing systems to allow prediction of fire behavior and smoke dispersion up to 2 days in advance of prescribed fires or wildfires. When overlaid with fire danger maps, these predictions help to illustrate where resources are needed to successfully implement prescribed fires or manage wildfire outbreaks. The information can also be used by communities in anticipating smoke impacts (Ferguson *et al.*, WA).

- Using information on historical fire patterns, past prescribed fire, road networks, forest type, and other factors, researchers have developed a modeling approach for estimating fire risk empirically. This approach may be used to evaluate targeted versus non-targeted vegetation management activities, determine economically optimal vegetation management approaches, and identify high-risk areas, especially in severe fire seasons in the Southeast (Prestemon *et al.*, NC).

Science is key to managing wildfire hazard in the most cost-effective and environmentally sensitive way. Research results are helping land managers to more cost effectively control wildfires and manage wildland fuels. Technologies of remote sensing and meteorological prediction are helping managers to better deploy firefighting resources.

- Making improvements in an emission production model used to estimate the variability in smoke and carbon dioxide emissions from wildland fires under different fuel loadings, meteorological conditions, and vegetation types. The model can be used to identify geographic areas that, if burned, would lead to particularly heavy visibility impairment through heavy smoke emissions and transport (Sandberg *et al.*, OR).

Technology Transfer and Partnerships

Progress in technology transfer in this key area of research spans a spectrum from information on California spotted owl habitat to improvements in delivery of fire-weather information and predictions of smoke movement.

- A preliminary analysis from research on California spotted owl home ranges indicates areas could be prescribe-burned to lower the risk of canopy fires without any measurable effect on the reproductive success of the owls. This information suggests that there is more flexibility in managing both fire and owls than previously thought. A regional team is considering this finding in developing management direction for the national forests in the Sierra Nevadas (Lee *et al.*, CA).

- Researchers have developed daily fire-weather projections out to 24 - 48 hours and a real-time modeling system for predicting smoke trajectories for several regions of the country. These models and projections are available for use by fire managers at the Federal, State, and local levels to aid firefighting activities and planning (Ferguson *et al.*, Heilman *et al.*,WA, MI).

- During the Hayman Fire in Colorado and the Rodeo Fire in Arizona, 24-hour, computer-generated, "research grade" weather predictions were provided for multiple point locations, including fire locations, and tanker and helicopter bases to assist fire managers (Zeller *et al.*, CO).

Research Advances

Scientific advancements are being made in the areas of fire-weather prediction and modeling fire intensity, spread, and smoke movement.

- Methodology developed to express the degree of uncertainty in fire spread model predictions will enable fire planners to predict fire growth and indicate the precision of fire growth projections. The result is better risk assessment in the planning process (Fujioka *et al.*, CA).

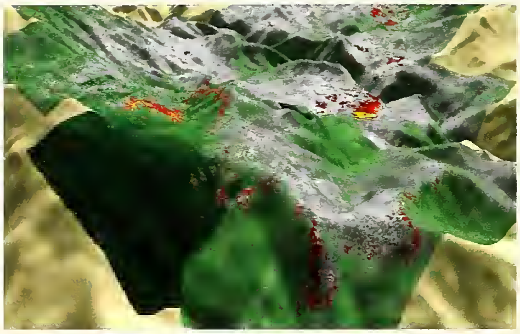
- Coupled fire-atmosphere computer simulations show large differences in behavior for fires within the Haines Index category 6. (The Haines Index is used to assess above-surface air mass as it affects large and/or erratic wildland fires.) This result is extremely important for aiding firefighting efforts because it is relevant to forecasting fire risk and behavior, especially for fires with potential for explosive, violent growth, and for wind. This work is leading to the development of new operational indices for predicting erratic and dangerous fire behavior (Heilman *et al.*, MI).

Researchers are working to deliver better tools for predicting fire and smoke.

- Scientists conducted prescribed burning experiments to study plume height and smoke dispersion using LIDAR (Light Detection and Ranging—a technique similar to radar) technology. This was the first experiment to measure plume heights in real time from a mobile scanning ground-based instrument, and it has demonstrated the utility of LIDAR for investigating smoke plume properties in harsh conditions (Hao *et al.*, MT).

Research Highlight

Where there's smoke, there's fire—remote sensing penetrates the smoke to find the fire



FireMapper thermal imagery of the northeast line of the McNalley Fire, Sequoia National Forest, at 14:00 to 14:30 hrs on 25 July 2002. Nadir images were collected from the PSW Airborne Sciences Aircraft and disseminated in part by satellite communications. FireMapper measures the radiance of emitted thermal-infrared light, which readily penetrates smoke. The false-color image shown here depicts the apparent surface temperature (in Celsius) as estimated from radiance and a simple blackbody model. Warmer tones represent recent or active combustion; areas of gray are cooling ash or warm bare ground. Low temperatures of unburned forest and cool ground are shown in green. Images have been geographically referenced. This three-dimensional depiction was created by draping an image mosaic over a digital elevation model. Vertical exaggeration is 1.5 to one.

Aircraft equipped with infrared imagers allow observers to "see through" smoke to detect lightning-ignited fires and map fire areas. But imagers used in fire suppression today are limited in their ability to measure large wildland fires and may provide a limited or distorted view of fire activity. Furthermore, aircraft used to make these types of observations are nationally deployed and thus may not be readily available for monitoring any given, fast-moving wildfire. New technology is needed to extend beyond the limitations of infrared imagers currently in use. More accurate measurements of the intensity and dynamics of fire fronts—properties that affect the rate of fire spread, smoke production, and forest damage—are needed to make fire information readily and widely available.

The Pacific Southwest Research Station (PSW) of the Forest Service, in partnership with the Pacific Southwest Region, is now flying aircraft equipped with the FireMapper thermal-imaging radiometer to map and monitor major wildfires. Based on modern night-vision technology, the FireMapper is designed to accurately map surface temperatures associated with major fire fronts and spot-fires alike and to provide fire intelligence more rapidly and cost effectively. This information can improve firefighter safety, make firefighting more effective, and reduce wildfire damage to natural resources and society. Imaging with the FireMapper system is also being tested for use in burned-area rehabilitation. The FireMapper system and associated mapping cameras are deployed aboard the PSW's Airborne Sciences Aircraft, a twin-engine Piper Navajo. The FireMapper was deployed during 2002 over major wildfires on the Cleveland, Los Padres, San Bernardino, and Sequoia National Forests and in Riverside and Los Angeles Counties.

PSW is continuing to develop the FireMapper system in cooperation with Space Instruments, Inc., of Encinitas, California. The new FireMapper 2.0 is intended to make modern infrared technology widely available in fire operations and to include direct measurement of flame intensity. FireMapper 2.0 will be tailored to aircraft and fire suppression activities in California and will be deployed first in conjunction with the Pacific Southwest Region.

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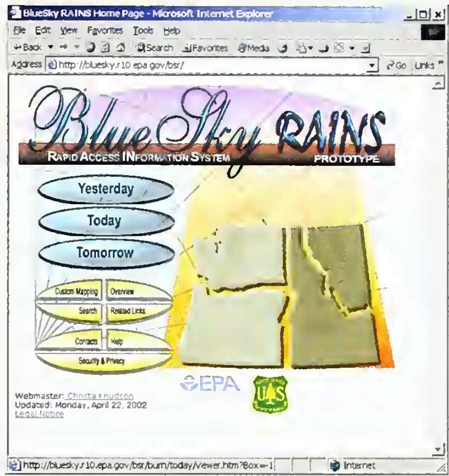
Research Highlight

BlueSky—new modeling tools to predict impacts from fire and smoke



One of the fundamental obstacles to implementing an aggressive prescribed fire program is smoke. While thousands of people may accept harmful smoke concentrations for long periods of time during wildfires, citizens have very little tolerance for smoke from prescribed burning. In addition, regulatory agencies require that land managers become more active in smoke modeling and real-time emission tracking to improve adherence to National Ambient Air Quality Standards, new regional haze rules, and State and tribal implementation plans.

Responding to this need, researchers are developing an automated, real-time, Web-based smoke-modeling framework called "BlueSky" that shows cumulative effects of smoke from prescribed burning in agricultural areas and forests across land ownerships and that creates an efficient emissions tracking system.

The BlueSky smoke-modeling framework is being developed in close collaboration with a community of advisors, managers, and scientists. These advisors have organized themselves into the Northwest Smoke Modeling Committee (NSMC). Members include Federal and State agencies, universities, and tribal governments.

During FY 2002, as part of this research effort, three new Web sites were created to facilitate delivery of information on smoke emissions. The "Smoke and Fire" Web site (http://www.atmos.washington.edu/gcg/smokeandfire/), which was developed first, provides users with easy access to the meteorological components of the BlueSky system and was widely used by weather forecasters and meteorologists throughout the Northwest during the 2002 fire season.

Second, the FireCAMMS Web site (http://www.fs.fed.us/fcamms) was developed to link users to fire and smoke modeling centers in other parts of the country. Third, a preliminary Web site for BlueSky (http://www.BlueSkyRAINS.org) was created to show real-time animations of surface smoke concentrations from wildland fires in the Northwestern United States. This Web site was used to monitor potential smoke impacts from the Quartz Mountain Wildfire Complex in north-central Washington and help plan its containment strategies.

BlueSky RAINS, a system that integrates weather, fire, and smoke predictions with the Environmental Protection Agency's Rapid Access INformation System, became available in early FY 2003. The combined site enables fire managers to overlay maps of fire location, fire danger, weather, and smoke dispersion with physical and geographic factors.

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Northwest Smoke Modeling Consortium
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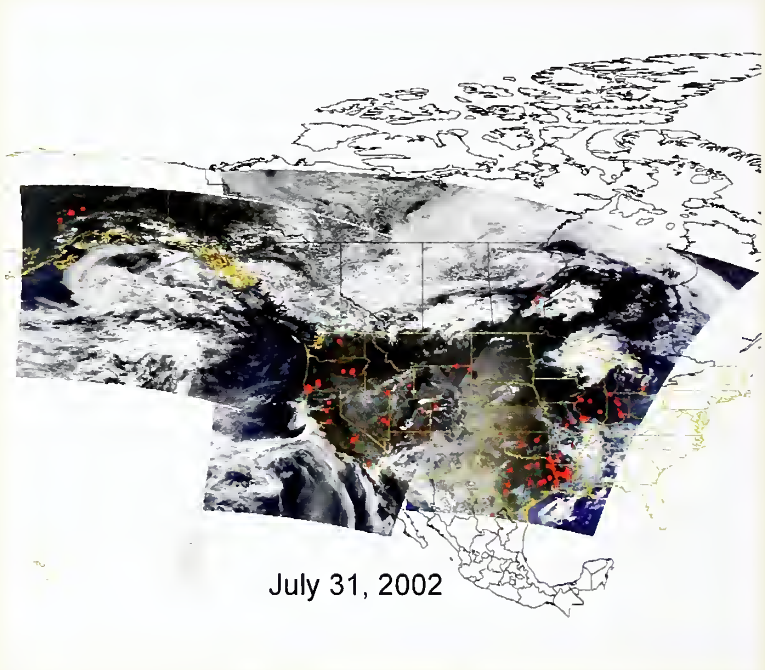
Research Highlight

Satellite provides daily smoke and fire tracking

On a snowy Montana morning in early March, a 4.2-meter antenna was installed on the roof of the Fire Sciences Laboratory of the Rocky Mountain Research Station (RMRS) in Missoula to receive data from NASA's MODIS (Moderate Resolution Imaging Spectroradiometer) instrument on board the Terra and Aqua satellites. Since early May, researchers have produced daily imagery of fires nationwide in collaboration with the NASA Goddard Space Flight Center, the University of Maryland, and the Forest Service Remote Sensing Applications Center.



The satellite receiving station was installed to support research that will lead to improved ability to detect fires in real time and enhance smoke forecasting capabilities. In the future, hot spots identified through satellite imagery can be used to map out burn scars to more accurately estimate the amount of pollutants emitted by fires. Eventually the data will be useful in monitoring health hazards due to smoke plumes and will aid in determining ideal conditions for prescribed burns.

A crucial component of the research project is the validation of the fire information derived from MODIS data. The record-breaking 2002 fires in Colorado and Arizona, while tragic, enabled researchers to obtain calibrated aerial thermal imagery of the Hayman and Missionary Ridge fires and to better understand the quality, accuracy, and limitations of the satellite data. The large extent of the fires also provided a unique opportunity to collect data over diverse fuel types, various burn intensities, and variable terrain.

The research efforts on the Hayman and Missionary Ridge fires also led to collaboration between fire managers and research stations. Active fire locations from the MODIS system, along with newly acquired georeferenced aerial thermal imagery, were provided to the National Interagency Fire Center, Geographic Area Coordination centers, and incident command teams for use as a firefighting tool.

The MODIS receiving station has and will continue to open new doors for Forest Service researchers. Canadian scientists also download the active fire locations daily. The receiving station's quick turnaround time will allow for smoke forecasting, ultimately making this space-age technology a real-time, on-the-ground tool for fire operations managers.

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Remote Sensing Applications Center

Research Highlight

Regional climate and fire danger modeling for the Pine Barrens of New Jersey

Twenty-two percent (1.1 million acres) of New Jersey's land area is occupied by the Pine Barrens, a volatile combination of pitch pine and scrub oak vegetation that historically burned every 25 years. Large (100,000+ acre) fires were common before concentrated efforts were made to suppress wildfires.

Changing land use, increased development, and decades of fire suppression have created a complex wildland-urban interface magnifying the fire problem in the New Jersey pinelands. Fire managers have identified the need for a reliable fire danger rating system for this region as their number one priority. Although fire danger rating systems have been developed for western ecosystems, these western fuel-based models do not meet the needs of wildfire managers in the Northeast. This may be due to several factors, including the unique characteristics of the vegetation, the low water-holding capacity of the soil, and the high humidity levels from the maritime influence.

An improved fire danger rating system specific to the Pine Barrens would enable fire managers to more strategically and cost effectively position firefighters and machinery in response to fires. Improved prediction of longer term fire-weather conditions and fire-season severity with the new model will help in long-term planning and budgeting for fire protection. A multidisciplinary approach is being taken to improve the existing fuel model. This includes enhancing the fire-weather monitoring for the region, analysis of historical fire climate records, sensitivity analysis and modeling of component indices in the National Fire Danger Rating System (NFDRS), and experimental monitoring of prescribed burns over a range of climate and humidity conditions.

The New Jersey Forest Fire Service is the primary partner and user of the improved NFDRS for the Pine Barrens. It is providing logistics support, fire history, and fire management treatment mapping for the research area, as well as conducting yearly prescribed burns for research purposes. The Pinelands Field Station, Rutgers University, is providing facilities and research sites for tower research and prescribed burns. Ongoing Rutgers atmospheric chemistry, nutrient cycling, and prescribed burn research in the pinelands will provide supplementary information to this effort. Fire-weather and fire-climate products developed in collaboration with the Forest Service Eastern Area Modeling Consortium will be utilized to address long-term, regional climate and weather impacts on fire and fire danger in the Pine Barrens.

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Eastern Area Modeling Consortium

Research Highlight

A strategic assessment of fuel reduction treatment opportunities in the West

The forests of the West experienced yet another bad fire season in 2002 with record costs and acres burned. This season's severity is symptomatic of a deeper forest health problem: compared to historical levels, today's forests are supporting far too many trees, due to the cumulative effects of forest growth, disturbance (fire) prevention, and management restrictions. This plethora of trees literally adds fuel to the flames when wildfires start. The judicious use of mechanical thinning and prescribed fires can reduce tree numbers to levels that restore forest health and rob the flames of fuel. However, in the face of limited resources, these fuel-reduction treatments need to be focused in areas where an overabundance of trees has altered forest/fuel characteristics enough to detrimentally change the frequency and intensity of wildfires.

In coordination with the NFP, the national forest inventory database maintained by the Forest Inventory and Analysis (FIA) program of the Forest Service was employed for a strategic assessment of fuel-reduction opportunities in the West. Combining the forest resource information from over 150,000 western sample locations in the database provides a big-picture look at western forests and the fuel-reduction opportunities available.

The 15 Western States encompass almost a billion acres of land; a quarter of this land is forest land and approximately half the forest land is classified as timber land (productive forests). Based on a comparison of existing tree stocking to desired (not overstocked) levels, the assessment indicated that treatment opportunities exist on three-quarters of the 130 million acres of timber land. FIA plot locations representing these overstocked areas were cross-referenced with areas categorized by the Forest Service as being at greatest risk of large severe fires (Condition Class 3 lands). The 29 million acres under these conditions represent a potential biomass yield of 576 million dry tons. Although less daunting, the fuel reduction task associated with these hotspots is still sizable. The potential biomass yield from these areas is 11 times greater than the West's 1996 timber product harvest and would require the removal of almost 6 billion trees.

The FIA assessment identified areas in greatest need of fuel reduction treatments in 15 western states. The congruence of some of these hotspots with recent wildfires demonstrates the great potential for using FIA data to identify areas where intervention could restore forest health before the next wildfire.

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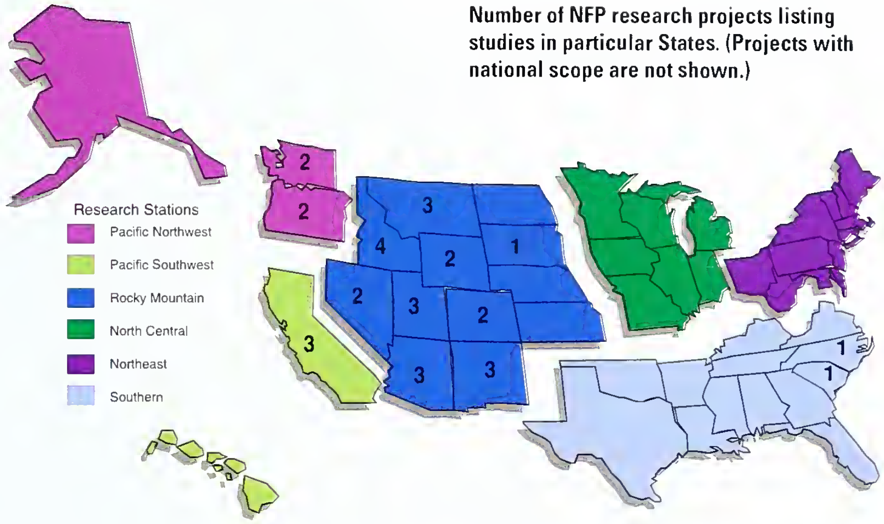
Accomplishments: Rehabilitation and Restoration



Number of NFP research projects listing studies in particular States. (Projects with national scope are not shown.)

Minimizing postfire erosion and flooding damage and optimizing conditions for recovery of native vegetation in burned areas are topics actively being investigated by NFP researchers. Benefits to managers are already accruing through the research process. Managers are involved in helping researchers identify and select study sites—including areas burned during the 2002 fire season. Researchers are sharing preliminary results on improving postfire revegetation success and minimizing invasion by exotic weeds with national forest personnel through special reports and consultations. Syntheses of research on rehabilitation and restoration of burned areas are being targeted to managers. A sampling of accomplishments from research on rehabilitation and restoration are highlighted below.

Technology Transfer and Partnerships

- In Montana, researchers have conducted a comprehensive survey to identify locations of noxious weeds throughout the Helena National Forest. This spatially explicit information on weed location has been shared with the Helena's range manager and can be used by forest personnel to target weed management efforts and rank weed species abundance (Markin *et al.*, MT).

- Working in partnership, scientists and national forest managers in Colorado have discussed the regeneration of two pine species (*Pinus aristata* and *Pinus flexilis*) after recent fires (Topaz Mountain burn—April 2002; Hayman Fire—June 2002) and past fires (Packer Gulch—August 1978). The discussions have led scientists to investigate pine regeneration success after fire and how it is influenced by physical and biological factors (Schoettle *et al.*, CO).

- Researchers have provided revegetation specialists in the Western United States with a synthesis of information on plant

Strong user-scientist partnerships are at the heart of effective technology transfer.

material availability and current research. The synthesis provides a ready resource for managers in making decisions about restoring and rehabilitating burned areas (Shaw *et al.*, ID).

Research Advances

- Studies in northern Arizona focus on how ectomycorrhizal fungi associated with ponderosa pine are impacted by different stand treatments. These fungi enhance tree vitality by helping tree roots absorb water and nutrients from the soil. Results indicate that the fungi were more vigorous and occurred in greater numbers in thinned stands. Fungi in stands that had been thinned and then prescribe-burned did less well than fungi in either the untreated or thinned stands. In severely burned stands the ectomycorrhizae were most negatively impacted. To achieve more vigorous and diverse ponderosa pine ecosystems in northern Arizona, the data suggest, prescribed burning should not be used exclusive of other types of treatments (Clancy *et al.*, AZ).

Research Highlight

How do wildfires affect aquatic ecosystems?

Throughout the Western United States, national forest lands provide freshwater for humans and habitat for plants and animals. Most of the freshwater habitats in the region are small streams. The stark, sun-baked landscapes sometimes left behind after severe wildfires pass through offer particularly harsh conditions for the species found in these environments. In the short term, loss of shading may cause streams to heat up more rapidly and become less suitable for species that depend on cold water, including threatened bull trout and chinook salmon. Fire-induced loss of vegetation and changes in soil characteristics can also lead to an increased potential for erosion, including large landslides, sedimentation, and flooding. Sometimes landslides, sedimentation, and flooding have clearly negative effects, but at other times they may lead to creation of new habitat.

Observations about the dramatic effects wildfires can have on streams and aquatic species have been pieced together from case histories of wildfires on only a few watersheds; managers would benefit from having more complete information. With this information, they could better assess where and when wildfires pose potential threats or benefits to fish and associated species in aquatic ecosystems.

Responding to this scarcity of information, scientists at the RMRS's Boise Aquatic Sciences Laboratory recently hosted a workshop to summarize current understanding of the potential risks and benefits of wildfire on aquatic ecosystems. Managers and scientists participating in the workshop identified key information needs and summarized existing theory and research. As a result of this workshop, Forest Service and university biologists and physical scientists, and national forest personnel are collaborating to gather information on the linkages between fire history and stream channel characteristics, the relationship between fire disturbances and fish populations, and methods of quantifying the physical and biological responses of streams to fire.

The approach taken here involving managers and scientists from a diversity of disciplines in gathering information to help guide selection of management alternatives is a model of cooperation worthy of imitation. More information on the recent workshop is available at the following Web site: http://www.fs.fed.us/rm/boise/teams/fisheries/fire/workshopdescription.htm.

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Salmon-Challis, Payette, Sawtooth, and Boise National Forests
U.S. Geological Survey

Research Highlight

The trouble with thistles

Severe wildfires often leave behind harsh conditions, including a virtual sterilization of soil, that open the door for the rapid invasion of exotic weedy species once the flames die down. Weeds, by their very nature, are hardy opportunists that can survive and thrive in degraded areas where other plants are unable to live. They are also vigorous competitors that can quickly dominate a site and force out native plants and animals. Although some casual viewers may see beauty in a field of blooming thistles, the ecologist sees a degraded, unhealthy ecosystem.

Photo shows the Shirttail Fire, in Wind Cave National Park. The area burned in 1991 in a wildfire; the area shown in the picture had almost 100 percent crown mortality, and became a patch of Canada thistle in 1992. The noxious weed is uncommon in this area now, but no doubt waits in the seedbank to take advantage of the next hot fire. The people shown in the photo are members of the National Park Service Fire Monitoring Crew that assisted RMRS scientist Dr. Carolyn Hull Sieg in re-sampling these plots in 2002.

The exotic weed problem is not easily solved. Researchers and managers still do not know exactly what variations in fire frequency and severity favor or discourage their invasion and spread. Prescribed fire is one tool that might be used in weed control, but it is critical to understand the dynamics of the fire-weed relationship to attain desired results.

Researchers in Arizona are collaborating with the National Park Service to learn how wildfires of different severities affect the invasion and spread of Canada thistle. In some instances, they are using experimental plots burned over by wildfires as their outdoor laboratories. Money provided for research on restoration and rehabilitation of fire-adapted ecosystems through the NFP has provided the needed boost for more researchers to tackle the far-reaching and intractable problem of exotic invasive weeds.

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Stephen F. Austin University

Research Highlight

Restoring sagebrush-grass and pinyon-juniper woodlands

In the sagebrush-grass and pinyon-juniper woodlands of the inland West, the increased dominance of exotic fire-adapted annual weeds is a big problem. Once weeds such as cheatgrass get a toe-hold, the ecosystem is often propelled into a downward spiral of increased fire frequency, fewer native herbs and shrubs, and even more cheatgrass.

A team of scientists at RMRS's Shrub Sciences Laboratory in Provo, Utah, and their cooperators are mounting a well-coordinated attack on exotic weeds on a number of fronts. They are looking at the genetic structure of populations of several forb, grass, and shrub species to see where the native plants' strengths and weaknesses lie in the competition against exotic weeds. In another effort, scientists are evaluating the possibility of using a naturally occurring smut fungus as a biological control for cheatgrass.

Successful drill seeding on the left and weedy control site on the right.

Scientists are also learning about the importance of a proper seedbed for the successful establishment of seeded plants after fire. Covering seeds has been found to be important in establishing seedlings. Running chains over an area to prepare the seedbed prior to conducting aerial seeding reduced establishment of cheatgrass. Tests on a variety of seed mixes—including a traditional seed mix of mostly introduced plants, two native plant mixes, and a mix of selected plants applied by drilling or from the air—demonstrated that all of these mixes can be successfully established.

As a result of this work, managers should soon have more effective means of controlling cheatgrass and the added option of using native plants to restore these fire-ravaged ecosystems.

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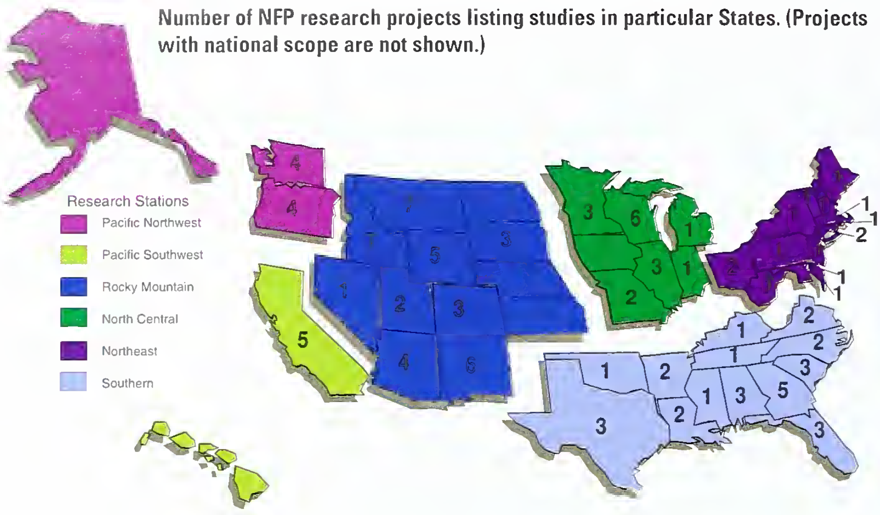
Accomplishments: Hazardous Fuels Reduction

Number of NFP research projects listing studies in particular States. (Projects with national scope are not shown.)



New investigations are underway to facilitate fire risk assessment, anticipate treatment impacts, and develop new uses and systems for harvesting forest undergrowth and small-diameter trees. Mapping and modeling efforts are directed at determining where the most dangerous fuel buildups occur now and predicting where they will occur in the future. Science-based risk assessments and fuel treatment methods will ensure that fuel treatment dollars are being spent in the best ways and in the right places. A sampling of accomplishments resulting from research on hazardous fuels reduction appears below.

Tool Development

Tools under development to assist managers in reducing hazardous fuels include new simulation models, new photo series, and modifications of a fuel consumption model.

- Information generated from simulation modeling of forest land in northern Minnesota is helping Superior National Forest staff members to adapt their management plans to incorporate wildland fire use strategies in the Boundary Waters Canoe Area Wilderness. The simulations suggest that reintroducing fire would increase landscape heterogeneity and probably reduce fuel loading and fire risk (Crow *et al.*, MN).

- A landscape-scale model depicting all significant vegetation types, natural disturbances, and management activities has been developed by scientists for use by national forests and other land managers in Oregon to evaluate potential long-term, cumulative ecological effects of fires and fuel treatments and to prioritize those treatments (Barbour *et al.*, OR).

- Stereo photo series were completed as a tool for quantifying natural fuels from on-the-ground stereo photography in the pinyon-juniper, chaparral, and sagebrush types of the Southwest. These tools will aid fire and fuels managers in assessing fuel loadings in these fuel types for planning prescribed fire and assessing fire risk (Sandberg *et al.*, OR).

Technology Transfer and Partnerships

Research findings related to hazardous fuels reduction are being transferred to managers through maps, software, research syntheses, Web sites, and GIS tools.

- Maps showing the probability of fires occurring under each of seven proposed management alternatives were given to the Chequamegon-Nicolet National Forest Land Management Planning Team in Wisconsin. Additional maps were provided to show the expected intensity of fires that could occur under each alternative. The team can use these maps to visualize how the alternatives will affect fire risk across the landscape and to graphically communicate these risks to the public (Gustafson *et al.*, WI).

- A Web site (http://ag.arizona.edu/SRER) has been developed that gives managers easy access to historical repeat photography and study results of the effects of prescribed fire on southwestern woodland vegetation. The Web site also provides documentation of fire effects and fuel management practices and options applicable to communities in the Southwest (Edminster *et al.*, AZ).

- GIS tools have been developed that enable managers to assess forest wildfire risk to humans. The index is based on the size and characteristics of contiguous forest patches adjacent to human developments. These GIS tools also enable managers to identify the heavily forested areas that are most likely to experience increased wildfire ignitions due to human encroachment (McNulty *et al.*, NC).

- Forest Service scientists are working with land managers in California to set up a schedule for fuels reduction treatments for FY 2003. Scientists are field-testing proposed treatments to ensure a credible basis for integrating fuels treatments into management plans for habitat management and management for threatened wildlife species (Keane *et al.*, CA).

Research Advances

Among the scientific advancements from research on hazardous fuels reduction is an improved understanding of how fire intervals and intensity affect sedimentation and soil characteristics. The effects of herbivores on fuel characteristics are being investigated.

- Analysis of fire interval and resulting sediment yield indicates

All fuels and fire decisions being made in the National Fire Plan concern risks. These decisions are tradeoffs among probable events with varying impacts on different resources or values. These risks must be weighed against the effects and the costs of actions, or lack of action, to deal with them. Science seeks to reduce uncertainty and clarify consequences.

that reducing the fire interval from the current average of 22 years to a prescribed fire interval of 5 years would reduce sediment yield by 2 million cubic meters in the 86-square-kilometer southern California watershed adjacent to and including the Angeles National Forest. These preliminary results suggest that reducing the debris basin cleanout required could save local governments as much as $40 million (Hubbert and O'Dea *et al.*, CA).

- Research on soil temperature and heat flux from a controlled burn shows that a fire-related heat pulse can penetrate to a depth of more than 1 meter. Soil may require as much as 2 weeks to recover to a normal daily temperature cycle. Ultimately, this information will help managers conduct controlled burns to maximize ecosystem benefits while minimizing the potential for harm such as excessive soil heating (Joyce *et al.*, CO).

- Researchers have developed methods to estimate the effects of management activities such as fuel reduction treatments and disturbances such as fire on the availability of forage and habitat for hoofed animals (ungulates). Managers can use this information to evaluate and disclose potential effects of fuel reduction, other management activities, and fire on both wild and domestic ungulates (Barbour *et al.*, OR).

Research Highlight

Improved fire behavior models for southwestern ecosystems

Advances in wildfire models are increasing the ability to anticipate and respond to fires, especially in the complicated situations that occur with a variety of live and dead fuels, complex topography, and fire-influenced winds. These improved models are critical to developing effective strategies for protecting lives and property in the wildland-urban interface. In addition, there is a pressing need to link fire behavior models to postfire effects and mitigation treatments that affect soil erosion, chemistry, productivity, and re-vegetation. Due to computational complexity and fine-scale resolution, these process models cannot be implemented yet in real-time situations.

These photos show two views from the same point in the burn area of the Penasco Fire of Aprill 2002 on the Lincoln National Forest in New Mexico. The area in the top photo was thinned in the 1960s and partially harvested in the last decade. The adjacent area in the bottom photo had not received an adequate treatment to reduce wildfire effects.

RMRS is working with the Department of Energy at Los Alamos National Laboratory to develop predictive models of fire behavior. These models are needed to support fuels reduction thinning treatments, wildfire mitigation efforts, planning for prescribed burns, and evaluation of potential fire behavior. Physical-process models that couple topography-influenced atmospheric flows with physics-based fire models have demonstrated sensitivity to these more complex conditions, and they provide more accurate results over short burn periods than current operational models. With further validation and development, these models can be used as training, planning, and risk assessment tools.

Researchers are developing, validating, and refining wildfire behavior models to southwestern conditions using data on vegetation and environmental conditions provided by a host of Federal and university partners. These steps are necessary for all models, including physical-process wildfire models, such as FIRETEC being developed by Los Alamos National Laboratory. FIRETEC includes representations of combustion, wind interactions with fuels, heat transfer mechanisms, and fire-influenced atmospheric flows. By examining model performance as applied to southwestern conditions and field data, scientists are able to diagnose potential limitations of the models and begin improvements in the areas of their deficiencies.

Although the 2002 fire season has impacted studies in the Southwest and delayed experimental field treatments at least 1 year, progress is still being made. The outputs expected from this research will contribute significantly to the development of simpler, computationally efficient models that can serve as critical tools in fire operations.

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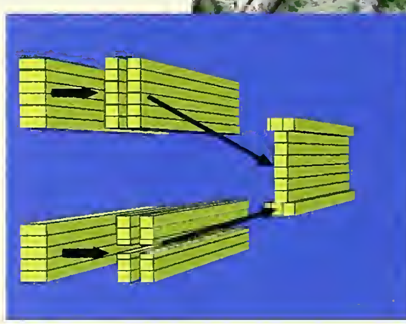
Research Highlight

Developing marketable products for small-diameter crooked timber

During logging or thinning operations undertaken to reduce the volume of hazardous fuels, low-value timber such as small-diameter, crooked, or cull trees may be left standing or on the ground. Saw or lumber mills are not equipped to handle this material; even if they were, there is little market for the lower quality material.

Curved or cull material presents several problems in a mill. First, it is difficult to cut a rectangular 2 by 4 or 2 by 6 section the full length of an 8-foot board without some corner sections showing bark areas (wane). From a structural viewpoint a little wane does not degrade strength properties much, but customers do not want to buy boards with wane so this material has lower value. Another problem with small-diameter trees is that they contain a higher percentage of juvenile wood that may cause bow, twist, or cup in the 2 by 4 during drying and that is also weaker than mature wood.



All this vegetative material still represents a valuable fiber resource, and researchers are developing structural products to utilize it. Cooperators at Wyoming Sawmill in Sheridan, Wyoming, have developed a product called LamHeader that uses economy-grade stud material and manufactures a laminated engineered I-shaped header product with engineered performance.

The Forest Products Laboratory (Madison, Wisconsin), Bighorn National Forest, Wyoming State Forest, Wyoming Sawmill, University of Wyoming (Laramie, Wyoming), and Genesis Laboratories (Batavia, Illinois) are working together to determine if small-diameter curved and cull trees can be used to produce this value-added laminated structural product. Small-diameter curved and cull trees were cut from the Bighorn National Forest and Wyoming State forest lands (July 2001) and processed into standard 2 by 4s at the Wyoming Sawmill. After being dried, they were tested for strength properties at the University of Wyoming and brought back up to Wyoming Sawmill (July 2002) to be glued and fabricated into 24-foot-long I-beams. Further strength testing was done at the University of Wyoming.

If the I-beams are able to carry sufficient design loads for structural applications, this opens a number of opportunities for improved forest management tools for using small-diameter, low-value material. In this way, the small-diameter material that might have otherwise been fuel for the next forest fire could be used for the next house or commercial building.

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Research Highlight

Baker City Watershed Pilot Demonstration Project—where there is smoke, there are scientists

The Baker City Municipal Watershed within the Wallowa/Whitman National Forest, Oregon, provides unfiltered potable water to 10,000 people. This watershed is currently at risk of severe wildfire due to the high fuel accumulations that could jeopardize Baker City's water supply. The watershed was selected as a national pilot demonstration site for fuel treatment options, including thinning and prescribed fire. This work to reduce the risk of severe wildfire in the watershed was initiated with support from the NFP and the JFSP.

Roger Ottmar from the Pacific Northwest Research Station is pulling a wire tight to monitor the smoldering consumption rate of this ponderosa pine log.

At the request of the Wallowa/Whitman National Forest, the Fire and Environmental Research Applications Team (FERA) of the Forest Service's Pacific Northwest Research Station (PNW) provided a science basis for fuel treatment decisions and completed required monitoring of fuel changes over time for each phase of the pilot project. FERA also coordinated several research projects funded by the NFP and the JFSP to study the fuel consumption, heat release, smoke production, and movement of smoke from the prescribed burning portion of this pilot demonstration.

Thirty scientists from both FERA and the Fire Effects, Fire Behavior, and Fire Chemistry Projects of RMRS's Missoula Fire Laboratory deployed a series of experiments requiring 60 ground fuel and fuel consumption monitoring plots, 2 smoke sampling towers, 2 trace gas and radiation sensing instruments, a radiation imaging aircraft, a tethered smoke sampling balloon, and a network of 6 weather stations on the perimeter of the burn. These inventory plots and instruments were used to monitor total and rate of fuel consumption; small woody and forest floor fuel moisture content, temperature, relative humidity, wind speed and direction, and precipitation; ground and aerial heat release; ground-level smoke emissions during the flaming and smoldering phases of the fire; and aerial smoke drift concentrations down-valley of the burn.

The data collected from this field-based effort will be used to improve the predictive capability of fuel consumption models such as CONSUME and the First Order Fire Effects Model (FOFEM), and the Emission Production Model (EPM), and smoke dispersion models such as CALPUFF and VSMOKE. Information gathered in this effort will help scientists refine computer models to provide managers with better tools for predicting how much smoke will be emitted by a fire and where that smoke will go and concentrate. Such information enables managers to plan prescribed fires to minimize smoke impacts.

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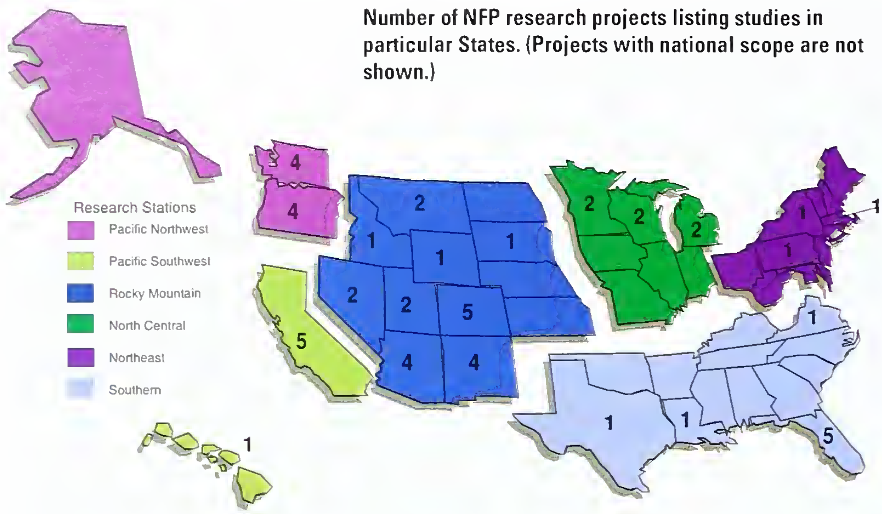
Baker City Ranger District
Pacific Northwest Region, Fire and Aviation Management
Rocky Mountain Research Station

Accomplishments: Community Assistance

Number of NFP research projects listing studies in particular States. (Projects with national scope are not shown.)



Researchers are working to provide managers with information they can use in helping communities better prepare for wildfires. Studies looking at fire preparedness are targeted at both the community and individual homeowner levels. Other research is focused on understanding people's beliefs, attitudes, and knowledge related to fire and fuels management treatments. Research on the economic impacts of fire on communities is already yielding interesting findings. A newly initiated research project focused on mapping the wildland-urban interface is attracting a lot of interest and attention. A sampling of accomplishments from research on community assistance appears below.

Tool Development

Recent efforts in tool development in this key area focus on providing information to homeowners and managers via the Internet.

- In the South, researchers have compiled information on the cost and effectiveness of a wide variety of regulatory, incentive-based, and educational programs currently used to reduce fuels accumulation in fire-prone areas. A Web site has been established (http://www.wildfireprograms.com) that enables local governments to access information to help develop fire protection programs in wildland-urban interface areas. Policymakers may review features of 20 programs, laws, and ordinances (to date) that address vegetation modification to mitigate fire hazards. User feedback indicates that the Web site is a useful tool for establishing a base of knowledge in developing fire protection policy (Haines *et al.*, LA).

- An Internet-based encyclopedia of southern fire science and management knowledge is under development. Scientists are synthesizing and integrating the past 50 years of southern fire science research, translating it into an Internet-based encyclopedia system, and developing a mechanism for updating the system as new knowledge becomes available. The goal is for this

encyclopedia to accommodate users of varying skill levels and interests and incorporate programmed "intelligence" to help users in decisionmaking and problem solving (Kennard *et al.*, GA).

Technology Transfer and Partnerships

Technology transfer efforts being carried out by scientists in California are centered on encouraging homeowners to adopt firewise landscapes around their homes.

- In South Lake Tahoe, California, researchers are developing a Web-based interface that would enable homeowners to use the computer to evaluate different options for increasing their fire safety on the basis of cost, building energy use, and other factors—just by entering information about their houses and surrounding vegetation. The model is based on detailed information on structures and vegetation for 102 residential properties in South Lake Tahoe (McPherson *et al.*, CA).

Research Advances

Over the past year, researchers have been asking recreation visitors in fire-prone areas about their perceptions of fire management and have been finding that managers need to explain more clearly when constraining visitor behavior. In addition, researchers have begun work on mapping the wildland-urban interface within the continental United States and projecting its growth to 2030.

- In California, researchers found that recreation visitors are not overly concerned with fire management, although some visitors are concerned about constraints on their behavior such as not being able to have fires in pits/grills, decreased air quality, and traffic delays due to fire suppression. Managers may need to provide clear messages to visitors about fire management and explain why no fires are allowed, why air quality is lower, and why traffic is delayed (Chavez *et al.*, CA).

- In 2002, NFP funds were awarded to a research project focused on mapping the wildland-urban interface within the continental United States and projecting its growth to 2030. Work to date on this project has focused on the development of techniques for forecasting housing density and identifying the wildland-urban interface (Dwyer *et al.*, IL).

Research Highlight

Wildfire preparedness: lessons from Minnesota's Gunflint Trail

Installing sprinklers is just one step residents along the Gunflint Trail are taking to increase their preparedness for wildfire. The intent is for the microclimate created by the mist of water generated from the sprinkler to stall any wildfire as it approaches this homeowner's property. (Photo courtesy of Wildfire Sprinklers, Inc.)

Reducing fire risk is a concern of many communities on the wildland-urban interface across the country. Even in areas not traditionally considered at high risk from fire, storms, changing climate, and pest and disease outbreaks have directed community attention to the potential for catastrophic fires. Programs such as FIREWISE and FireFree (a public awareness campaign in Oregon) are based on anecdotal evidence and research that suggest that communities can take steps to reduce their risk from wildfire.

In the first of a series of case studies on wildfire preparedness, scientists interviewed people who live, work, and recreate along the Gunflint Trail in northeastern Minnesota. Fire has always been a critical part of this landscape, but it has been even more critical since a major windstorm in 1999 blew down trees on more than 600 square miles of forest land in the region.

Based on interviews with the Gunflint Trail residents, researchers identified five keys to wildfire preparedness on the Gunflint. First, residents need to know the fire history of the area and understand the role of fire in their ecosystem. Second, people should use existing networks and relationships to increase wildfire preparedness. Third, residents can increase wildfire preparedness by building on local knowledge and skills. Fourth, public land management agencies in the area need to recognize the importance of building relationships and maintaining an open door policy. Finally, people need to recognize that choosing to live and work in an isolated area, surrounded by wilderness, in a fire-prone ecosystem comes with the responsibility of being involved in wildfire preparedness activities.

Building on what was learned on the Gunflint, guidelines for successful community preparedness include the following:

1. Develop homeowner wildfire preparedness packets, or adapt existing educational materials so they are specific to your community.
2. Take steps to "professionalize" your volunteer fire department through training, benefits, and recognition.
3. Encourage local residents to take the lead in wildfire preparedness activities, supported by county, State, or Federal agency staff.
4. Use existing business and landowner associations as the backbone of your wildfire preparedness program.
5. Make existing public programs work for you.
6. Ask for help (money, materials, and time) from all community members.

More detailed information on this project can be found at the following Web site: http://www.ncrs.fs.fed.us/4803/Highlights.htm

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Research Highlight

Preventing wildland-urban interface fire disasters

Through a combination of computational modeling, quantitative experiments, and examination of case studies, a RMRS researcher has discovered that characteristics of the home ignition zone (the home's exterior characteristics and immediate—within 60 meters—surroundings) are key to whether or not the home will burn.

A key take-home message from his work is that "the little things" matter when talking about preventing home ignitions. In other words, homes do not necessarily become rapidly engulfed in flames from an intense wildland fire; rather, destruction begins as small ignitions that take time, possibly hours, to involve the home in fire. In most cases the big flames of high-intensity fires do not occur close enough to homes to directly cause ignitions. Instead, a home is ignited by lower intensity surface fire spreading to it or by firebrands (lofted burning embers).

These findings suggest opportunities for preventing residential fire disasters during intense wildland fires. Homeowners can reduce the home ignition potential by replacing flammable wood roofs and cleaning flammable debris from on and around the home to keep fire from spreading to or igniting directly on the home. Thinning and pruning trees and shrubs adjacent to the home and removing debris from under and within trees and shrubs will also reduce a home's ignition potential and increase the effectiveness of fire protection resources.

Findings from this research are featured in a new video, "Wildfire: Preventing Home Ignitions," sponsored by the FIREWISE Communities USA Project. More than 3,000 copies of the video have been distributed to agencies and homeowners since January 2002.

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Key Partners:
Interagency Wildland Urban Interface Program/FIREWISE Communities

Research Highlight

Impact of wildfires on local economies

Beyond the obvious impacts on forests and wildlands, catastrophic wildfires have complex and far-reaching impacts on capital and commerce in nearby communities. Buildings, timber, livestock, and powerlines may be lost. After such fires, the consumption and production of goods and services are disrupted, and recreation and tourism immediately decline. In the long term, the structure of the local economy may be significantly altered.

Researchers are using a variety of methods and approaches to better understand the economic impacts of fire. Early research findings on the impacts of fires in Montana in 2000 showed that the wildfires led to immediate reductions in timber harvest and tourism and to minimal local benefits from expenditures for suppression. On the other hand, wildfires led to substantial benefits for the timber market from salvage. Questions about how governments affect economic losses by facilitating timber salvage are being studied.

In related research efforts, a report coming out in mid-2003 on a recently completed case study in the Bitterroot Valley of Montana will provide insights into the net economic and social impacts of wildfire on the community. Researchers are just beginning to empirically evaluate who pays and who gains from Federal expenditures on wildland fire management.

This body of research will help policymakers and land managers better understand the diversity of economic impacts associated with wildfire and may help to lower overall economic impacts and Federal expenditures in the wake of future fires. Further information can be found at the following Web site: http://www.rtp.srs.fs.fed.us/econ/dert

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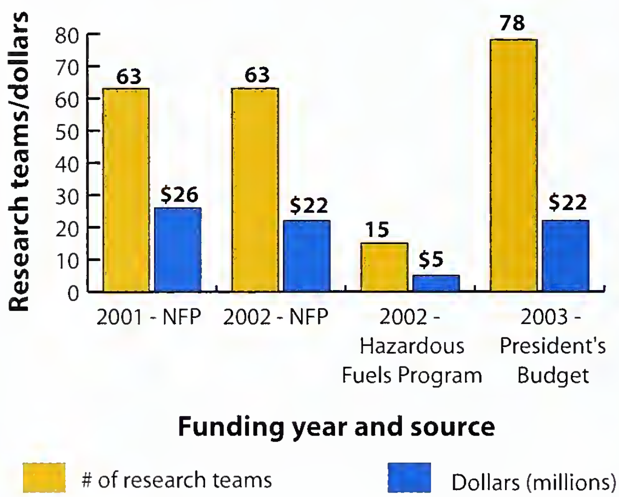
FY 2002: A Year of Momentum and Challenges

FY 2002: A Year of Momentum and Challenges

In FY 2001, Forest Service R&D used NFP money to fund 63 research projects in the areas of firefighting, rehabilitation and restoration, hazardous fuels reduction, and community assistance. In FY 2002, these 63 research teams received continued funding for a second year's work. In addition, another request for proposals was issued in 2002 and 15 new research teams were funded with an additional $5 million from the hazardous fuels budget of Forest Service State & Private Forestry.

FS NFP R&D Funding and Projects by Year



NFP research begun in FY 2001 progressed rapidly in FY 2002. In addition, NFP dollars enabled funded teams to accelerate delivery to the field of useful products from previous research, thereby capturing a high return on taxpayers' investments in earlier years. Resources supplied to seven Forest Service research stations and their partners have allowed fire researchers to become more responsive to the unique challenges and opportunities posed by large fires and high-risk areas. For example, many of the studies begun in the wake of the Bitterroot fires that occurred in Montana in 2000 and the fires of 2001 and 2002 are funded with NFP R&D dollars.

Setbacks in 2002 disrupted the research momentum. In the summer of 2002, the extreme fire season created the need to borrow funds from within the Forest Service. This included borrowing from most of the NFP R&D teams to cover suppression expenditures, further disrupting commitments to cooperators as well as hiring plans. Planned agreements with other agencies, universities, nongovernmental organizations, and private sector cooperators have been put on hold, further delaying essential research. Efforts to build a pool of fire scientists for the future have been sidetracked.

Moving Ahead

Moving Ahead

The support for fire research provided through the NFP in FY 2001 and FY 2002 has enabled Forest Service R&D and its cooperators to accelerate research efforts and to speed development and delivery of technology transfer products and tools to the field. Within the limits of available funding, the programs begun in FY 2001 and FY 2002 will be continued in FY 2003 in an effort to maximize program stability, accomplish key objectives, and initiate or continue planned cooperative agreements.

Differences Between NFP Research and the JFSP

Key differences between NFP research and the JFSP are their mission, focus, and research goals. NFP research is targeted at four key areas—firefighting capacity, rehabilitation and restoration, hazardous fuels reduction, and community assistance. The JFSP has historically centered on hazardous fuels management, although it has expanded in the last year with additional direction from Congress. NFP research teams are being funded to encourage long-term research; JFSP projects tend to be short term. NFP research provides scientific support for reducing fire risks; JFSP provides technical support and tools for the interagency fuels management program.

Research Coordination and a National Fire Research Agenda

The impetus of the NFP R&D program has encouraged the Forest Service and its research partners to organize a more comprehensive strategic vision of needs and priorities for fire research. It is now time to reexamine the kinds of research needed and to realign research programs to meet those needs. To move the fire research program in this direction, the interagency Fire Research Coordination Council (FRCC) was formed in 2002.

The FRCC is composed primarily of representatives from Federal organizations and agencies having a fire research component. Its mission is to provide leadership in coordinating and representing wildland fire science at the national level. The council strives for effective and efficient approaches to accomplishing the research and development missions of research providers in the public, private, academic, and nongovernmental sectors. The FRCC promotes the application of science and technology to find new solutions to fire management and policy problems. One of its major goals is to maintain public trust and respect in fire research and development by identifying and interpreting important science gaps and user needs, jointly exploring fire research problems, and wisely investing in research and development activities.

In FY 2003, the FRCC plans to develop an intergovernmental fire science agenda and explore the idea of integrated centers of excellence—virtual labs, consisting of local institutions; Federal resource agency research units; national labs; and universities whose programs are organized around important fire science and technology gaps, unique regional problems, and transfer of technology to users. These fire science centers would respond to national and regional needs and would develop leadership and technical talent in fire science and fire management. In addition, they would provide ready access to high-quality information and knowledge about fire, fire

management, and fire ecology, and they would improve the local communities' access to and understanding of fire science and management principles.

Keys to a Viable and Responsive Fire Research Program

In moving ahead with a national fire research program, the following four key emphasis areas have been identified as critical to the future success of the fire research venture and its ability to support fire management through delivery of products and tools: building a balanced science base, facilitating science and technology adoption, developing a mechanism for rapid-response research, and supporting a core fire science program. Concentrated efforts and investments in these areas not only will ensure scientific advancements in fire science, but will also improve the service of the research organization to the managers on the ground.

Building a Balanced Science Base

The foremost challenge for fire research is to ensure scientific capability that is appropriate to the scope and complexity of the fire problem. Future improvements in the effectiveness and efficiency of fire and fuel management programs will be very difficult to achieve without concurrent investment in R&D. Expanded fuels and fire management efforts lead to a greater need for science. The science foundation guides the development of new policies, predicts and evaluates the impacts of sweeping management changes, and provides tools for managers and communities.

Research funded yesterday is solving problems today.

Serving the multiple needs of fire managers, land managers, community leaders, and residents requires a careful balance of research capacity across several dimensions. Applied science and tool delivery must be balanced with bold initiatives in fundamental science to address pivotal uncertainties. National processes and patterns must be understood but not to the exclusion of efforts to address regional or local fire regimes and urban interface situations. Research on short-term responses or on active fires must be conducted alongside long-term measurements to quantify delayed consequences of fires and fire management actions. These balances are maintained with a variety of scientists with different interests and capabilities. The National Fire Plan is allowing the development of this balanced capacity in the Federal agencies, in the universities, and in the private sector.

Facilitating Science and Technology Adoption

Forest Service R&D has sustained an active fire research program since the 1920s and remains the world leader in wildland fire science and related fields.

The demands for science-based information are growing. The Internet has made it easier for managers and private citizens to quickly access a vast array of often conflicting information from sources of varying reliability. Questions about the consequences of fire and fuels operations at larger ecological and social scales demand a different frame of explanation and scientific investigation. Scientists are using landscapes as laboratories, operational activities as experiments and demonstrations, and systematic monitoring to provide scientific knowledge and lessons for users.

Ensuring that new science and technology gets put into practice requires concerted efforts at science synthesis, interpretation, and outreach. The unprecedented funding that is being allocated for mitigating fire problems provides a great opportunity for improving mechanisms and processes for technology transfer. Improvements would help ensure that important research findings and tools are effectively transferred to users and would establish a clearer pathway for stakeholders to partner with the research community on urgently needed fire-related research.

To address this need, the Forest Service and its partners in the FRCC are establishing an interagency planning and technology transfer working group. This group will recommend guidelines and standards to ensure that applied fire research projects achieve productive partnerships between science and the appropriate manager(s). The group is identifying critical technology transfer needs and will develop accountability standards for tracking outputs and outcomes in technology transfer efforts. The group will also consider the organizational changes that might be necessary to ensure that research results are effectively synthesized, transferred to users, and implemented in planning processes.

Preliminary discussions indicate that a possible solution to current problems in technology transfer would be development of an interagency technology transfer cadre consisting of science communication specialists from fire management agencies, university extension, and other organizations who are dedicated to bringing research results into practice and providing user feedback to the research community.

Developing a Mechanism for Rapid-Response Research

Some of the most important lessons to be learned about fire effects and ecosystem recovery come from rapid initiation of studies during or immediately after wildfires. Areas where previous research or monitoring has provided a wealth of baseline information, or where unique values are at risk, are excellent candidates for rapid-response research projects.

The Forest Service and its partners are trying to develop more effective mechanisms to enable rapid evaluation of potential opportunities, provide for allocation of funds, and facilitate deployment of science teams to newly burned areas. Rapid-response research can provide great benefits in the knowledge gained in those critical days and weeks following fires. Improved systems and sources of funding, such as the JFSP, will allow researchers the flexibility to respond to late season fire research opportunities. Keys to successful rapid response research include preplanning and support to get the right scientists to the right fires, and having in hand a well-designed set of research questions and an investigation strategy that can seize upon the unique advantages of the active fire as a laboratory. Not all fires provide insight worth the effort and cost. Some fires may be too unique to be generalizable or may not display the fire behaviors or other responses of interest. So, criteria for selecting fires must be rigorous; priority should be given to fires with mixtures of treated and untreated areas, with long-term research instrumentation, well-codified treatment baselines, and typical fuels and ecological conditions. Fire managers and line officers must understand the mission of quick response science teams, and the teams must be able to implement their studies within safe operating standards for fire suppression activity.

Supporting Core Fire Science

The core fire science capability in Forest Service R&D is a critical component of fire-related research and provides essential institutional support and staffing for NFP research. Without a continuing influx of new basic knowledge about fire effects on ecosystems and prediction of fire behavior, much of the applied ecological and economic research could be misdirected.

Scientific advancements and solutions to complex problems go hand in hand.

Many of the fire effects and behavior models and tools in use today were developed 15 to 20 years ago when support for fire research was much higher. These models are only beginning to be tested for the range of conditions in which they are now being applied. In some cases, scientists and managers are finding that predictions based on these models are subject to great uncertainty, especially when conditions are extreme.

Future investments in the NFP and in base R&D funding will focus on developing a strong cadre of fire scientists to carry out high-priority fire science research in the following areas:

- **Fire behavior in complex fuels and terrain**—understanding the impact of variability in fuels on fire;

- **Fuel moisture dynamics**—live fuels and moisture effects that are not covered in existing models, improved monitoring methods;

- **Prediction and measurement of fire severity and fire effects on plants, soils, and ecosystem processes**—the basis for estimates of higher level, more integrated prediction;

- **Fire-atmosphere interactions**—advanced understanding of the effects of weather on fire and vice versa; improved understanding of fire emissions.

Appendix

Table 1. Research Projects[1] and Team Lead Scientists

KEY POINT A – FIREFIGHTING (26 teams of reseachers)

Project ID Number	Project Title	Team Lead Scientist	e-mail address
01.NCS.A.1	National and regional fire weather dynamics: Improved methods for high resolution forecasting of fire weather and smoke transport	Warren E. Heilman	wheilman@fs.fed.us
01.NCS.A.2	Assessing vulnerability of populations to wildfire in the North Central Region **(98-1-5-03)**	Robert G. Haight David T. Cleland	rhaight@fs.fed.us dcleland@fs.fed.us
01.NCS.A.3	FIA pilot test of a fuel condition monitoring system	Dennis May	dmay@fs.fed.us
01.PNW.A.1	A modeling framework for real-time predictions of cumulative smoke impacts ("BlueSky") **(98-1-9-05, 98-1-9-06, 01-1-6-07, 01-1-6-08)**	Sue A. Ferguson	sferguson@fs.fed.us
01.PNW.A.2	Estimating haze from prescribed and wildland fires **(98-1-1-05, 98-1-1-06, 98-1-9-05, 01-1-6-01)**	David V. Sandberg	dsandberg@fs.fed.us
01.PNW.A.3	Seasonal prediction of national fire risks and impacts **(98-1-1-06)**	Ronald P. Neilson	rneilson@fs.fed.us
01.PNW.A.4	Fuel moisture mapping and combustion limits **(98-1-9-06)**	David V. Sandberg	dsandberg@fs.fed.us
01.PSW.A.1	Risks to fish and wildlife from wildfire and landscape treatments	Danny C. Lee	dclee@fs.fed.us
01.PSW.A.2	An initial attack model for fire management planning **(01-1-7-06)**	Marc Wiitala	mrwiitala@fs.fed.us
01.PSW.A.3	Fire behavior in live fuels	David R. Weise	dweise@fs.fed.us
01.PSW.A.4	Real-time remote sensing of fire properties	Philip J. Riggan	priggan@fs.fed.us
01.PSW.A.5	Weather models for area coordination centers	Francis Fujioka	ffujioka@fs.fed.us
01.RMS.A.1	Improving decisions for fuel treatment options **(98-1-8-06, 01-1-3-22)**	J. Greg Jones Jim Chew	jgjones@fs.fed.us jchew@fs.fed.us
01.RMS.A.2	Real-time fire monitoring nationwide **(01-1-5-03)**	Wei Min Hao	whao@fs.fed.us
01.RMS.A.3	New technology for monitoring smoke characteristics	Wei Min Hao	whao@fs.fed.us
01.RMS.A.4	Remote sensing, GIS, and landscape assessment tools for fire management **(98-1-1-07, 99-1-3-29, 00-1-3-19, 01-1-1-6)**	Colin Hardy Kevin Ryan	chardy01@fs.fed.us kryan@fs.fed.us
01.RMS.A.5	Fire management strategies for wilderness and other protected areas **(99-1-3-16, 01-1-1-05, 01-1-3-12)**	Carol Miller	cmiller04@fs.fed.us
01.SRS.A.1	Prediction of fire weather and smoke impacts in the Southeast	Gary L. Achtemeier	gachtemeier@fs.fed.us
01.SRS.A.2	Tradeoffs of alternative vegetation management strategies **(01-1-2-09)**	Jeffrey P. Prestemon	jprestemon@fs.fed.us
01.SRS.A.3	Establishing a wildland-urban interface research and technology transfer unit for the South	Pete Roussopoulos Edward Macie	proussopoulos@fs.fed.us emacie@fs.fed.us
01.SRS.A.4	Long-range forecasting of fire season severity	Dale Wade	rxfire@ix.netcom.com
01.SRS.A.5	Southern regional models for predicting smoke movement	Gary L. Achtemeier	gachtemeier@fs.fed.us
02.NES.A.1	Regional climate and fire danger modeling for the New Jersey Pine Barrens	John Hom	jhom@fs.fed.us
02.PSW.A.1	Improving monitoring and modeling of smoke contributions to regional haze **(01-1-05-06)**	Andrzej Bytnerowicz	abytnerowicz@fs.fed.us
02.RMS.A.1	Enhanced prediction of fire weather and smoke impacts in the Rocky Mountains and Southwest	Karl Zeller	kzeller@fs.fed.us
02.RMS.A.2	A nationwide system to generate a daily emissions inventory of pollutants from fires **(01-1-5-03)**	Wei Min Hao	whao@fs.fed.us

[1] Number in bold and parentheses following some titles indicates linkages to JFSP projects listed in Table 3.

Table 1. — Continued

KEY POINT B – REHABILITATION AND RESTORATION (12 teams of researchers)

Project ID Number	Project Title	Team Lead Scientist	e-mail address
01.PNW.B.1	Predicting spread of invasive species after fuel reduction treatments and postfire disturbance **(99-S-1, 01B-3-3-16)**	Edward J. DePuit	ejdepuit@fs.fed.us
01.PSW.B.1	Effectiveness of postfire emergency rehabilitation treatments in the West **(98-1-4-12, 01-3-2-08)**	Jan Beyers	jbeyers@fs.fed.us
01.RMS.B.1	Hydrologic and geomorphic consequences of wildfire and fuels management options in southwestern forest and woodland ecosystems **(99-S-1, 99-1-3-13)**	Daniel G. Neary	dneary@fs.fed.us
01.RMS.B.2	Native plant materials for restoration of sagebrush steppe and pinyon-juniper communities **(00-1-1-03)**	E. Durant McArthur	dmcarthur@fs.fed.us
01.RMS.B.3	Dynamics of weed invasions and fire in the northern Rockies	George Markin	gmarkin@fs.fed.us
01.RMS.B.4	Effects of wildfire and fire management options on invasive and exotic species and pathogens **(99-S-1)**	Karen Clancy	kclancy@fs.fed.us
01.RMS.B.5	Factors affecting Great Basin watersheds' susceptibility to invasive plants **(00-1-1-03, 00-2-15, 01B-3-3-01)**	Jeanne C. Chambers	jchambers@fs.fed.us
01.RMS.B.6	Patterns of white pine regeneration after fire	Anna Schoettle	aschoettle@fs.fed.us
01.RMS.B.7	The role of grassland fire in managing exotic and woody plants	Deborah Finch	dfinch@fs.fed.us
02.PNW.B.1	Response of native and invasive exotic plants to fire and fuel reduction treatments in the interior Pacific Northwest	Catherine Parks	cparks01@fs.fed.us
02.RMS.B.1	Characterizing risks of wildfire and fuels management in aquatic ecosystems	Bruce Rieman	brieman@fs.fed.us
02.SRS.B.1	Modeling the effects of wildfire on sediment and nutrient loads in the Southeastern United States	James M. Vose	jvose@fs.fed.us

Table 1. — Continued

KEY POINT C – HAZARDOUS FUELS REDUCTION (29 teams of researchers)

Project ID Number	Project Title	Team Lead Scientist	e-mail address
01.FPL.C.1	Hazardous fuels reduction through harvesting underutilized trees and forest undergrowth and producing three-dimensional structural products	John F. Hunt	jfhunt@fs.fed.us
01.FPL.C.2	Utilization of small diameter crooked timber for use in laminated structural boards through development of new sawing, laminating, and drying processes	John F. Hunt	jfhunt@fs.fed.us
01.NCS.C.1	Optimizing fuel reductions in time and space **(01-1-3-43)**	Tom Crow	tcrow@fs.fed.us
01.NCS.C.2	Managing risk of fire on human and ecological communities in the wildland-urban interface	Eric Gustafson	egustafson@fs.fed.us
01.NES.C.1	Fuels and fire behavior in the Central Hardwoods **(99-S-1)**	Daniel Yaussy	dyaussy@fs.fed.us
01.PNW.C.1	Ground-based support for mapping fuel and fire hazard **(98-1-1-05, 98-1-1-06, 01-1-7-02)**	David V. Sandberg	dsandberg@fs.fed.us
01.PNW.C.2	Fuel reduction and forest restoration strategies that sustain key habitats and species in the interior Northwest **(99-S-1, 01-1-3-25, 01-1-6-01)**	John F. Lehmkuhl	jlehmkuhl@fs.fed.us
01.PSW.C.1	Effects of fuel reductions on stream ecosystems **(00-2-05)**	Carolyn T. Hunsaker	chunsaker@fs.fed.us
01.PSW.C.2	Alternatives to fire for fuel reduction in California shrublands within coniferous forest	Robert F. Powers	rpowers@c-zone.net
01.PSW.C.3	The effect of prescribed fire on hydrologic and soil processes that affect erosion in semi-arid systems	Ken Hubbert Mary O'Dea	khubbert@fs.fed.us modea@fs.fed.us
01.PSW.C.4	Effects of wildfire and fuel treatments on California spotted owl	John J. Keane Peter A. Stine	jkeane@fs.fed.us pstine@fs.fed.us
01.RMS.C.1	Impacts of exotic weeds on fuel loading and fire regimes **(00-1-1-03)**	Nancy L. Shaw	nshaw@fs.fed.us
01.RMS.C.2	Impact of fuel management treatments on fire behavior and forest vegetation **(99-1-1-04, 00-2-19, 00-2-20)**	Dennis E. Ferguson	deferguson@fs.fed.us
01.RMS.C.3	Impact of fuel management treatments on forest soil erosion and production **(98-1-4-12)**	William J. Elliot Deborah Page-Dumroese	welliot@fs.fed.us ddumroese@fs.fed.us
01.RMS.C.4	Management alternatives for fire dependent ecosystems in Colorado and the Black Hills **(98-1-5-01)**	Linda A. Joyce	ljoyce@fs.fed.us
01.RMS.C.5	Improved guidelines for fuels management in southwestern ponderosa pine and pinyon-juniper forests in wildland-urban interface areas **(99-S-1, 00-U-01)**	Carl Edminster	cedminster@fs.fed.us
01.RMS.C.6	Restoration techniques in lodgepole pine forests	Ward McCaughey	wmccaughey@fs.fed.us
01.RMS.C.7	Use of remote sensing to examine disturbance effects	John E. Lundquist	jlundquist@fs.fed.us
01.RMS.C.8	Riparian ecosystem dynamics in relation to fire in the Rocky Mountains **(01-1-3-19)**	Deborah Finch	dfinch@fs.fed.us

Table 1. — Continued

KEY POINT C – HAZARDOUS FUELS REDUCTION (29 teams of researchers)

Project ID Number	Project Title	Team Lead Scientist	e-mail address
01.SRS.C.1	Wildfire risk in the Eastern United States	Steve McNulty	steve_mcnulty@ncsu.edu
01.SRS.C.2	Quantifying the ecological and economic tradeoffs of fire and fire surrogate options—Piedmont and Southern Appalachian Mountains **(99-S-1, 01-1-4-02)**	Thomas A. Waldrop	twaldrop@fs.fed.us
01.SRS.C.3	Quantifying the tradeoffs of fire and fuels management options—Longleaf and slash pine ecosystems of the Atlantic and Gulf Coastal Plain **(99-S-1)**	Kenneth W. Outcalt	koutcalt@fs.fed.us
01.SRS.C.4	A system for mechanized fuel reduction at the wildland-urban interface	John Stanturf	jstanturf@fs.fed.us
01.SRS.C.5	Fire and herbicide combinations to reduce fire intensity **(00-2-27, 01-1-3-11)**	Dale Wade	rxfire@ix.netcom.com
02.FPL.C.1	Developing tools to assess economic feasibility of processing wood removed in the course of hazardous fuels reduction	Ken Skog	kskog@fs.fed.us
02.PNW.C.1	Integrated approach for assessing fire risk, disturbance patterns, and conducting analysis of fuel treatment strategies on large landscapes	Jamie Barbour	jbarbour01@fs.fed.us
02.PSW.C.1	Fire and fuels management, landscape dynamics, and fish and wildlife resources: Study design for integrated research on the Plumas and Lassen National Forests	Peter Stine	pstine@fs.fed.us
02.RMS.C.1	Environmental and economic impacts of biomass reduction **(98-1-4-12, 01-3-2-08)**	William J. Elliot	welliot@fs.fed.us
02.RMS.C.2	Effects of wildland fire and fuel treatments on terrestrial vertebrates in Intermountain forests **(01-1-3-25)**	William Block Victoria Saab	wblock@fs.fed.us vsaab@fs.fed.us

Table 1. — Continued

KEY POINT D – COMMUNITY ASSISTANCE (11 teams of researchers)

Project ID Number	Project Title	Team Lead Scientist	e-mail address
01.NCS.D.1	Modeling people's responses to landscape treatments **(99-1-2-08, 99-1-2-10)**	John F. Dwyer	jdwyer@fs.fed.us
01.NCS.D.2	Community partnerships	Pamela J. Jakes	pjakes@fs.fed.us
01.PSW.D.1	Recreation and fire in the wildland-urban interface **(99-1-2-10)**	Deborah Chavez	dchavez@fs.fed.us
01.PSW.D.2	Firewise residential landscapes	Greg McPherson	egmcpherson@ucdavis.edu
01.RMS.D.1	Building consensus on fire management	Brian Kent	bkent@fs.fed.us
01.RMS.D.2	Preventing residential fire disasters at the wildland-urban interface	Jack D. Cohen	jcohen@fs.fed.us
01.SRS.D.1	Impact of wildfires on local economies **(01-1-2-09)**	Jeffrey P. Prestemon	jprestemon@fs.fed.us
01.SRS.D.2	Fire protection in residential expansion areas	Terry Haines	thaines01@fs.fed.us
02.NCS.D.1	Mapping the wildland-urban interface and projecting its growth to 2030 **(99-1-2-08, 99-1-2-10)**	John F. Dwyer	jdwyer@fs.fed.us
02.RMS.D.1	Community knowledge, beliefs, attitudes, and practices concerning fire and fuels management in southwestern ecosystems	Carol Raish	craish@fs.fed.us
02.SRS.D.1	An Internet-based encyclopedia of southern fire science and management knowledge	Deborah Kennard	dkennard@fs.fed.us

Table 2. Summary of Accomplishments in FY 2002

Accomplishment	Firefighting[1]	Rehabilitation and Restoration[2]	Hazardous Fuels Reduction[3]	Community Assistance[4]	TOTAL
Studies Initiated	77	48	121	39	285
Agreements/Contracts Established	40	15	76	31	162
$$ Value of Agreements (1000s)	2,507	686	3,219	1,901	8,313
Permanent Scientists/Professional Hired	8	2	4	1	15
Term Scientists/Professionals Hired	13	5	21	1	40
Permanent Technicians Hired	2	1	1	0	4
Term/Temp. Technicians Hired	9	53	98	6	166
Refereed Publications	10	14	33	8	65
Non-Refereed Publications	19	29	41	10	99
Presentations at Scientific Conferences	87	60	94	41	282
User Bulletins, Leaflets Produced	25	4	18	9	56
Decision Support Tools, Models Developed	22	1	28	3	54
Demonstrations, Tours Hosted	40	23	51	12	126
Significant Consultations with:					
Regions, National Forests, Districts	75	54	100	44	273
States, State Foresters	41	14	33	27	115
Tribal Governments	3	3	4	2	12
County, Local Governments	8	17	10	54	89
Other	26	10	28	75	139
Short Courses, Workshops, Training Offered	27	15	44	11	97
Communities Assisted	3	8	7	23	41
Fire Management Units Assisted	25	3	16	15	59

[1] Breakdown of funding for firefighting accomplishments: NFP (77%), JFSP (7%), base fire science program (9%), other sources (7%)

[2] Breakdown of funding for rehabilitation and restoration accomplishments: NFP (74%), JFSP (13%), other sources (13%)

[3] Breakdown of funding for hazardous fuels reduction accomplishments: NFP (72%), JFSP (6%), base fire science program (1%), other sources (21%)

[4] Breakdown of funding for community assistance accomplishments: NFP (85%), JFSP (1%), other sources (14%)

Table 3. JFSP Research Projects with Linkages to Forest Service NFP Research Projects[1]

Project ID Number	Project Title	Team Lead Scientist
98-1-1-05	Photo series for major natural fuel types of the United States – Phase II **(01.PNW.A.1, 01.PNW.C.1)**	Roger Ottmar
98-1-1-06	Application of a fuel characterization system for major fuel types of the contiguous United States and Alaska **(01.PNW.A.2, 01.PNW.A.3, 01.PNW.C.1)**	Roger Ottmar
98-1-1-07	Mapping fuels using remote sensing and biophysical modeling **(01.RMS.A.4)**	Robert Keane
98-1-4-12	Risk assessment of fuel management practices on hillslope erosion processes **(01.PSW.B.1, 01.RMS.C.3, 02.RMS.C.1)**	Peter Robichaud
98-1-5-01	Fire regimes and fuel treatments: a synthesis with manager feedback **(01.RMS.C.4)**	Phil Omi
98-1-5-03	Characterizing historic and contemporary fire regimes in the Lake States **(01.NCS.A.2)**	David Cleland
98-1-8-06	A risk based comparison of potential fuel treatment tradeoff models **(01.RMS.A.1)**	David Weise
98-1-9-05	Implementation of an improved emission production model **(01.PNW.A.1, 01.PNW.A.2)**	David Sandberg
98-1-9-06	Modification and validation of fuel consumption models for shrub and forested lands in the Southwest, Pacific Northwest, Rockies, Midwest, Southeast, and Alaska **(01.PNW.A.1, 01.PNW.A.4)**	Roger Ottmar
99-S-1	A national study of the consequences of fire and fire surrogate treatments **(01.PNW.B.1, 01.RMS.B.1, 01.RMS.B.4, 01.NES.C.1, 01.PNW.C.2, 01.RMS.C.5, 01.SRS.C.2, 01.SRS.C.3)**	Jim McIver
99-1-1-04	Development and delivery of the fire and fuels extension to the forest vegetation simulator for use by stakeholders to the Joint Fire Science Program **(01.RMS.C.2)**	Nicholas Crookston
99-1-2-08	Evaluating public response to wildland fuels management: factors that influence acceptance of practices and decision processes **(01.NCS.D.1, 02.NCS.D.1)**	Bruce Shindler
99-1-2-10	Demographic and geographic approaches to predicting public acceptance of fuel management at the wildland-urban interface **(01.NCS.D.1, 01.PSW.D.1, 02.NCS.D.1)**	Jeremy Fried
99-1-3-13	Carbon and nitrogen cycling by microbial decomposers following thinning and burning in a southwestern ponderosa pine ecosystem **(01.RMS.B.1)**	Daniel Neary
99-1-3-29	Southern Utah fuels management demonstration project **(01.RMS.A.4)**	Kevin Ryan
00-1-1-03	Changing fire regimes, increased fuel loads, and invasive species: effects on sagebrush steppe and pinyon-juniper ecosystems **(01.RMS.B.2, 01.RMS.B.5, 01.RMS.C.1)**	Jeanne Chambers
00-1-3-19	Monitoring fire effects at multiple scales: integrating standardized field data collection with remote sensing to asess fire effects **(01.RMS.A.4)**	Robert Keane
00-U-01	Cerro Grande post-fire inventory and analysis **(01.RMS.C.5)**	Carl Edminster
00-2-05	Kings River and Lake Tahoe Basin demonstration sites for fuel treatments **(01.PSW.C.1)**	Carolyn Hunsaker
00-2-15	A demonstration area on ecosystem response to watershed-scale burns in Great Basin pinyon-juniper woodlands **(01.RMS.B.5)**	Jeanne Chambers

Table 3. — Continued

Project ID Number	Project Title	Team Lead Scientist
00-2-19	Stand and fuel treatments for restoring old-growth ponderosa pine forests in the interior West (Boise Basin Experimental Forest) **(01.RMS.C.2)**	Russel Graham
00-2-20	Treatments that enhance the decomposition of forest fuels for use in partially harvested stands in the moist forests of the northern Rocky Mountains (Priest River Experimental Forest) **(01.RMS.C.2)**	Russel Graham
00-2-27	Maintaining longleaf pine woodlands: is mechanical shearing a surrogate for prescribed burning? **(01.SRS.C.5)**	Jeff Glitzenstein
01-1-1-05	Can wildland fire use restore historical fire regimes in wilderness and other unroaded lands? **(01.RMS.A.5)**	Carol Miller
01-1-1-6	Historical wildland fire use: lessons to be learned from 25 years of wilderness fire management **(01.RMS.A.4)**	Matthew Rollins
01-1-2-09	A national study of the economic impacts of biomass removals to mitigate wildfire damages on Federal, State, and private lands **(01.SRS.A.2, 01.SRS.D.1)**	Jeffrey Prestemon Karen Lee Abt
01-1-3-11	Duff consumption and southern pine mortality **(01.SRS.C.5)**	Kevin Hiers
01-1-3-12	Effects of prescribed and wildland fire on aquatic ecosystems in western forests **(01.RMS.A.5)**	David Pilliod
01-1-3-19	Effects of fuels-reduction and exotic plant removal on vertebrates, vegetation, and water resources in southwestern riparian ecosystems **(01.RMS.C.8)**	Deborah Finch
01-1-3-22	Optimizing landscape treatments for reducing wildfire risk and improving ecological sustainability of ponderosa pine forests within mixed severity fire regimes **(01.RMS.A.1)**	Merrill Kaufman
01-1-3-25	Prescribed fire strategies to restore wildlife habitat in ponderosa pine forests of the intermountain West **(01.PNW.C.2, 02.RMS.C.2)**	Victoria Saab
01-1-3-43	Fire, management, and land mosaic interactions: a generic spatial model and toolkit from stand to landscape scales **(01.NCS.C.1)**	Thomas Crow
01-1-4-02	Fuel classification for the southern Appalachian Mountains using Hyperspectral Image Analysis and Landscape Ecosystem Classification **(01.SRS.C.2)**	Tom Waldrop
01-1-5-03	Automated forecasting of smoke dispersion and air quality using NASA Terra and Aqua satellite data **(01.RMS.A.2, 02.RMS.A.2)**	Wei Min Hao
01-1-5-06	Improving model estimates of smoke contributions to regional haze using low-cost sampler systems **(02.PSW.A.1)**	Andrezj Bytnerowicz
01-1-6-01	Fire and climatic variability in the inland Pacific Northwest: integrating science and management **(01.PNW.A.2, 01.PNW.C.2)**	David Peterson
01-1-6-07	Assessing the value of mesoscale models in predicting fire danger **(01.PNW.A.1)**	Sue Ferguson

Table 3. — Continued

Project ID Number	Project Title	Team Lead Scientist
01-1-6-08	Predicting lightning risk **(01.PNW.A.1)**	Sue Ferguson
01-1-7-02	Photo series for major natural fuel types of the United States—Phase III **(01.PNW.C.1)**	Roger Ottmar
01-1-7-06	Techniques for creating a national interagency process for predicting preparedness levels **(01.PSW.A.2)**	Gerry Day
01-3-2-08	Risk assessment of fuel management practices on hillslope erosion processes (Phase II) **(01.PSW.B.1, 02.RMS.C.1)**	Peter Robichaud
01B-3-3-01	Effects of fire and rehabilitation seeding on sage grouse habitat in the pinyon-juniper zone **(01.RMS.B.5)**	Jeanne Chambers
01B-3-3-16	Effects of season and interval of prescribed burns in a ponderosa pine ecosystem **(01.PNW.B.1)**	Walter Thies

[1] Number in bold and parentheses following titles indicates linkages to Forest Service NFP projects listed in Table 1.

Table 4. 2002 Research Partners and Cooperators[1] for Forest Service NFP Research

Firefighting Capacity Research

1. Applied Physics Lab (WA)
2. Australian National University
3. Bearstar Enterprise (MT)
4. Brigham Young University (UT)
5. Capilano College, N. Vancouver, BC
6. Carroll Nelson Associates (MT)
7. Colorado State University
8. Digital Visions Enterprise Group (OR)
9. FireVision (WA)
10. GC Micro Corp. (CA)
11. Geo Data (MT)
12. Minnesota Department of Natural Resources
13. Montana State University
14. New Jersey Forest Fire Service
15. NOAA (TN)
16. North Carolina State University
17. Pacific States Marine Fisheries Commission (OR)
18. Patrick Freeborn (MT)
19. R. Lamar (CA)
20. Rutgers University Pinelands Research Station (NJ)
21. Scripps Institution of Oceanography (CA)
22. Space Instruments, Inc. (CA)
23. Systems for Environmental Management (MT)
24. Technology Service Corp. (CO)
25. TSI, Inc. (MN)
26. University of California, Berkeley
27. University of California, Santa Barbara
28. University of Hawaii
29. University of Idaho
30. Virginia Tech
31. Watershed Research and Training Center (CA)

Rehabilitation and Restoration Research

1. Brigham Young University (UT)
2. Colorado State University
3. Eastern Oregon University
4. Hollis Marriott (WY)
5. Montana State University
6. New Mexico State University
7. Northern Arizona University
8. Oregon State University
9. University of Idaho
10. University of Nevada
11. University of New Mexico
12. University of Washington

Hazardous Fuels Reduction Research

1. Adaptive Management Services – Pacific Southwest Region (CA)
2. Air Science Corp. (OR)
3. Associate Arborists of Chico (CA)
4. Auburn University (AL)
5. Bolton-Emerson Americas, Inc. (MA)
6. California State University, Fresno
7. Clemson University (SC)
8. Colorado State University
9. Crescent Technology (WI)
10. David Cook Tillage (CA)
11. Duck Creek Association (OR)
12. ESSA Technologies (Canada)
13. Kruger Enterprises (MA)
14. Los Alamos National Lab (NM)
15. Mantech Environmental Technology, Inc. (NC)
16. MATCOM (CO)
17. METI (TX)
18. Middle Rio Grande Conservancy District (NM)
19. Montana State University
20. New Mexico Department of Agriculture
21. North Carolina State University
22. North Carolina Wildlife Resources Commission
23. Northern Arizona University
24. Ohio State University
25. Ohio University
26. Oregon State University
27. PBS Environmental Consultants (WA)

[1] Lists represent partnerships, contracts, and cooperative agreements initiated in 2002 as part of research efforts by Forest Service NFP research teams.

Table 4. — Continued

Hazardous Fuels Reduction Research (cont.)	Community Assistance Research
28. Peaks Ranger District, Coconino National Forest (AZ)	1. Auburn University (AL)
29. Point Reyes Bird Observatory (CA)	2. California Polytechnic University, San Luis Obispo
30. Technological University of Plant Polymers (Russia)	3. Clemson University (SC)
31. Titan Systems, Inc. (OR)	4. Colorado State University
32. University of Arizona	5. INTECS International, Inc. (CO)
33. University of California, Berkeley	6. Integrated Resource Solutions (CA)
34. University of California, Davis	7. Louisiana State University
35. University of California, Riverside	8. North Carolina State University
36. University of California, Santa Barbara	9. Oregon State University
37. University of Georgia	10. Penn State University
38. University of Missouri	11. San Diego State University (CA)
39. University of Montana	12. Southern Oregon University
40. University of Nevada	13. Systems for Environmental Management (MT)
41. University of New Mexico	14. Tall Timbers
42. University of North Carolina	15. University of Arizona
43. University of Oklahoma	16. University of Florida
44. University of Washington	17. University of Georgia
45. University of Wisconsin	18. University of Illinois
46. University of Wyoming	19. University of Massachusetts
47. Forest Service Forest Inventory and Analysis (Washington, DC)	20. University of Minnesota
48. U.S. Geological Survey	21. University of Wisconsin
49. Wyoming Sawmill	22. Virginia Tech

Table 5. List of Special National-Scale Projects[1]

1. Biosum Project – National Assessment of Commercial Availability of Fuels for Utilization
2. Landscape Fire Behavior
3. Transition/Siege Fire Risk Investigation
4. Support for Fire Weather Modeling Consortia
5. Natural Inquirer (A Journal for Educators) – Special Edition on Fire Research
6. Support for Natural Hazards Center at the University of Colorado, Boulder

[1] National-level administration of the Forest Service NFP R&D program included financial support ($215,000) for travel for national team leaders, outreach and accomplishment reporting, and development of a joint project tracking database with the JFSP. In addition, money ($200,000) was invested in several short-term national-scale projects to answer key questions in NFP implementation and to further enhance the synergy among funded research teams. These projects included a national assessment of the commercial availability of fuels biomass, a cooperative fire behavior modeling effort with the Los Alamos National Laboratory, an evaluation of the potential for risk management on large fires, and the organization of a national network of weather and smoke modeling centers.

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Miscellaneous
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